Chapter 4
ANALYSIS OF ALTERNATIVE EFFECTIVENESS

This chapter presents the analysis of the effectiveness of the alternatives described in this report, including the common actions.

An accounting model of the Salton Sea has been developed to effectively evaluate the No Action Alternative and the alternatives considered. This model is a sophisticated spreadsheet model in Microsoft Excel 97 and @Risk, an add-on package produced by Palisades. The Salton Sea Accounting Model incorporates the ability to perform stochastic, deterministic, and risk and uncertainty simulations of the future Sea conditions. The model operates on an annual time step and was designed to meet specific objectives unique to the Salton Sea Restoration Project.

Where reduced inflows were analyzed, reductions in inflow are assumed to begin in the year 2002, with reductions of 10,000 acre-feet of water per year. This assumption provides a conservative approach to how inflow might be reduced within the Salton Sea Basin. At this rate, by about the year 2031, inflows would be at a level of about 1,063,000 acre-feet per year, and by 2058, inflows would be down to nearly 800,000 acre-feet per year. The 10,000-acre-foot-per-year rate of reduction represents a reasonable assumption on how changes will be reflected at the Salton Sea. Until the National Environmental Policy Act/California Environmental Quality Act process is completed relative to the proposed conservation projects, it is impossible to identify accurately how such measures might affect inflows to the Sea. The considerations that could affect the inflows are described in attachment B.

The objectives behind the model were to provide a tool that would allow the effective evaluation of historic and future conditions within the Salton Sea both with and without proposed alternatives. Specifically, the model was developed to predict changes in inflow, salinity, elevation, and surface area. Another objective is to provide a tool that allows the analysis of sensitivity related to model input parameters.

Numerous simulations for the Salton Sea have been performed for the No Action, phase 1 and 2 combination alternatives, and phase 1 only alternatives.

I. COMMON ACTIONS IN ALL ALTERNATIVES

For most of these actions, the effectiveness is based on a summary of the benefits and consequences presented in the environmental impact statement.

A. Fish Harvesting

Fish harvesting would provide a way to remove phosphates/nutrients from the Sea. However, reducing eutrophication is challenging. Some rough calculations suggest that large-scale harvesting of fish could reduce eutrophication. Use of the harvest could make this activity a long-term, profit-generating enterprise. Profit would increase in proportion to the success of the enterprise in removing nutrients.

Further assessment of this option requires work in testing the effectiveness of harvesting fish, in experimental, small-scale pilot projects; in testing meal quality; and in harvest technology and operations. Current estimates indicate that fish harvesting could remove only 1 percent of the fish.

If fish harvesting occurs in shallow water, pupfish could be affected. Operating the fish processing plant may produce odors. Long-term improvement in odors is expected through reduction of biomass in the Sea.

B. Shoreline Cleanup

Fish die-offs have occurred for decades at the Salton Sea; however, they appear to be increasing in frequency and severity. The California State Parks, Salton Sea State Recreation Area, estimated one event in 1984 included 4 million dead fish. An event during the summer of 1998 on the south end of the Sea was considered unprecedented by the U.S. Fish and Wildlife Service, and another in 1999 affected more than 7.5 million fish.

Typically, when fish die-offs occur, the bodies of the dead fish will float on the surface of the Sea or be washed ashore in harbors, channels, residential areas, beaches, and public areas.

If the actions described under shoreline cleanup are successful, the beaches and public areas would be cleared of the unsightly conditions, obnoxious odors, and other effects caused by the dead fish, including the removal of nutrient loads currently being returned to the Sea. A minor long-term beneficial effect to water quality could result due to cleanup of decaying organic matter along the shorelines. Beach cleanup of removing debris could result in minor local cloudiness in Salton Sea water and increased shoreline susceptibility to wind and water erosion.

C. Improved Recreational Facilities

Recreational use has generally declined at the Salton Sea over the past 40 years. Because many of the recreational amenities of the Sea are in disrepair or are nonfunctional, even efforts to study the Sea's ecology has been hampered by poorly maintained boat ramps, etc. It is expected that restoration efforts would stimulate significant visitation and use of the Sea.

Increased visitor use could result in a potential increase in the take of sportfish; however, the take would be managed to maintain a healthy fish population. If elevation is not stabilized, improvements would only be temporary. Improving recreation facilities should help reestablish the area's recreation base and provide some improvement in economic activity.

D. Integrated Wildlife Disease Program

Bird mortality at the Salton Sea is a high profile event. If resources would be available as outlined under this program, success should be forthcoming.

These programs would minimize losses from various causes of bird mortality and focus on early detection of outbreaks, timely and accurate diagnosis of the disease agents involved, appropriate response actions, and monitoring to determine if adjustments to response actions are needed. Positive employment effects may also result by improving fishing, boating, and bird watching. The visual quality of the shoreline and odor problems should be improved by this long-term program to reduce wildlife disease.

E. Long-Term Management Strategy Including Strategic Science Plan

The long-term management strategy and science program is a comprehensive life-of-the-project effort that would allow restoration managers to adapt restoration solutions to future changes in ecological conditions. The periodic monitoring and planning would alert managers to possible changes before they become problems. Beneficial impacts would result from introducing programs that would most likely prevent large scale die-offs and disease reduction. The science program may lead to actions that reduce the potential health hazards from biological pathogens at the Sea.

II. ALTERNATIVES, PHASES 1 AND 2

Stochastic simulations of the Salton Sea were run for three inflow levels—1,363,000 acre-feet per year, 1,063,000 acre-feet per year, and 800,000 acre-feet per year—for all alternatives. The results are that by the year 2100, the mean inflow would remain the same for the 1.36-million-acre-foot-per-year simulation; it would drop to about 1,063,000 by the year 2031, and it would drop to 800,000 acre-feet per year by about 2058.

During stochastic simulations of the Salton Sea, random samples from normal distributions representing historic inflows, evaporation, and precipitation are performed such that each 100-year trace (model iteration) is unique. In this mode, the model is typically executed 1,000 times and statistics-related model results are compiled. These statistics include, for each year, mean values, mean values plus one standard deviation, mean values minus one standard deviation, 5 percentiles, and 95 percentiles. The data are to be interpreted as follows:

95 percentile:	95 percent of all model traces resulted in values less than or equal to the indicated values
5 percentile:	5 percent of all model traces resulted in values less than or equal to the indicated values
Mean:	Mean of all traces
-1 standard deviation:	Values representing one standard deviation below the mean
+1 standard deviation:	Values representing one standard deviation above the mean

These simulations also project the Salton Sea salinity, elevation, and surface area for the three inflow levels. These projections are shown in the figures in attachment C. If no action were taken to restore the Salton Sea, by the year 2060, with a 800,000-acre-foot-per-year inflow, salinity concentrations could reach 177,848 mg/L, the elevation could be -249 feet m.s.l., and the water surface area could be only 169,400 acres. Even if inflows remained at 1.36 million acre-feet per year, salinity would reach 64,253 mg/L, and the elevation would be -223 m.s.l. in 2060.

The initial conditions used in the alternative simulations are that the simulations begin in year 2000 at a beginning elevation of -227.0 feet m.s.l., beginning salinity concentrations of 44,000 mg/L, and beginning surface area of 234,000 acres.

All phase 1 and 2 alternative model simulations project for the target salinity concentration of 37,500 mg/L and a target elevation of -232.0 feet m.s.l. This results in a naturally varying accounting model operating surface elevation of between -230 and -235 feet. These are considered acceptable target levels to achieve with any alternative.

The results of these simulations are shown in attachment C. Table 7 summarizes the modeling results after phase 1 at year 2030 and 2060 with and without phase 2 for the three inflows at 1.363, 1.06, and 0.80 million acre-feet per year. Figure 12 compares the salinity among the alternatives at 1.363, 1.06, and 0.80 million-acre-foot-per-year inflow. Figures 13 and 14 compares the elevation and surface area among the alternatives at 1.363, 1.06, and 0.80 million acre-foot-per-year inflow, respectively.

The following discussion of 1.063 million acre-feet per year is an example. This does not suggest that this will be the probable future inflow.

Under the evaporation ponds, Alternative 1, salinity increases to 49,360 mg/L per year by 2030 with inflows of 1.06 million acre-feet per year, and increases to 65,889 by 2060 with phase 1 only, but decreases to 34,742 by 2060 with phase 2 actions. The elevation decreases to -228 m.s.l. with the same inflows, but stabilizes at -232 m.s.l. by 2060 with phase 1 actions only.

With the EES, Alternatives 2 and 3, and inflows of 1.06 million acre-feet per year, salinity increases to 53,726 mg/L by 2030, decreases to 42,612 mg/L by 2060 with phase 1 only, and further decreases to 38,120 mg/L by 2060 with phase 2 actions. The elevation decreases to -237 by 2030, -245 by 2060 with phase 1 only, and raises to -232 by 2060 with phase 2 actions.

Under the EES and evaporation pond, Alternative 4, the salinity increases to 47,467 mg/L by 2030 under inflows of 1.06 million acre-feet per year, reduces to 44,823 mg/L by 2060 with only phase 1 actions, but reduces to 40,436 mg/L with phase 2 actions by 2060. Elevation lowers to -235 by 2030, -240 by 2060 with phase 1 only, but raises to -232 by 2060 with phase 2 actions.

Under the In-Sea EES, Alternative 5, salinity is 46,197 mg/L by 2030, 60,638 mg/L by 2060 with phase 1 only, and decreases to 37,343 mg/L by 2060 with phase 2 actions under inflows of 1.06 million acre-feet per year. Elevation lowers to -236 by 2030, -233 by 2060 with phase 1 only, and raises to -232 by 2060 with phase 2 actions.

Table 7.—Summary comparison of modeling results after phase 1, with and without phase 2 alternatives

Inflow rate/alternative	Phase 1 actions only 2030			Phase 1 actions only 2060			With phase 2 action 2060		
	Elevation (ft, msl)	Salinity (mg/L)	Surface area (sq mi)	Elevation (ft, msl)	Salinity (mg/L)	Surface area (sq mi)	Elevation (ft, msl)	Salinity (mg/L)	Surface area (sq mi)
Current inflow scenario, 1.36 maf/yr									
No Action	-224	52,896	377	-223	64,253	381	—	—	—
Evaporation ponds, Alternative 1	exceeds -220 (1,2)	N/A (1,2)	N/A (1,2)	exceeds -220 (2)	N/A (2)	N/A (2)	-227	27,196	331
EES at Bombay Beach or Salton Sea Test Base, Alternatives 2 and 3	-232	45,510	348	-234 (3)	37,042(3)	343 (3)	-234	37,042	343
EES and evaporation pond, Alternative 4	-229	39,566	338	-226	33,930	346	-229	31,165	336
In-Sea EES, Alternative 5	-232	40,854	341	-222	42,940	370	-231	33,926	342
Reduced inflow scenario, 1.06 maf/yr									
No Action	-234	75,050	341	-241	122,530	310	—	—	—
Alternative 1	-228 (1)	49,360 (1)	304 (1)	-232	65,889	296	-232	34,742	296
Alternatives 2 and 3	-237	53,726	308	-245	42,612	272	-232	38,120	326
Alternative 4	-235	47,467	298	-240	44,823	284	-232	40,436	306
Alternative 5	-236	46,197	306	-233	60,638	314	-232	37,343	317
Reduced inflow scenario, 0.80 maf/yr									
No Action	-234	75,043	341	-249	177,848	265	—	—	—
Alternative 1	-228 (1)	49,389 (1)	304(1)	-245	109,023	261	-234	38,203	292
Alternatives 2 and 3	-237	53,668	308	-257	65,657	222	-238	45,347	288
Alternative 4	-235	47,508	298	-253	73,370	240	-234	44,467	299
Alternative 5	-236	46,161	306	-243	88,821	276	-236	40,745	305

Notes: base year 2000
Elevation in base year: -227 ft msl
Salinity in base year: 44,000 mg/L
Surface area of Sea in base year: 233,898 acres (365 sq mi)

(1) Performance of Alternative 1, phase 1 actions does not include accelerated exports.
(2) Lake level exceeds elevation -220 ft prior to year shown. Model does not operate above elevation -220.
(3) Alternatives 2 and 3 do not include any additional phase 2 actions.

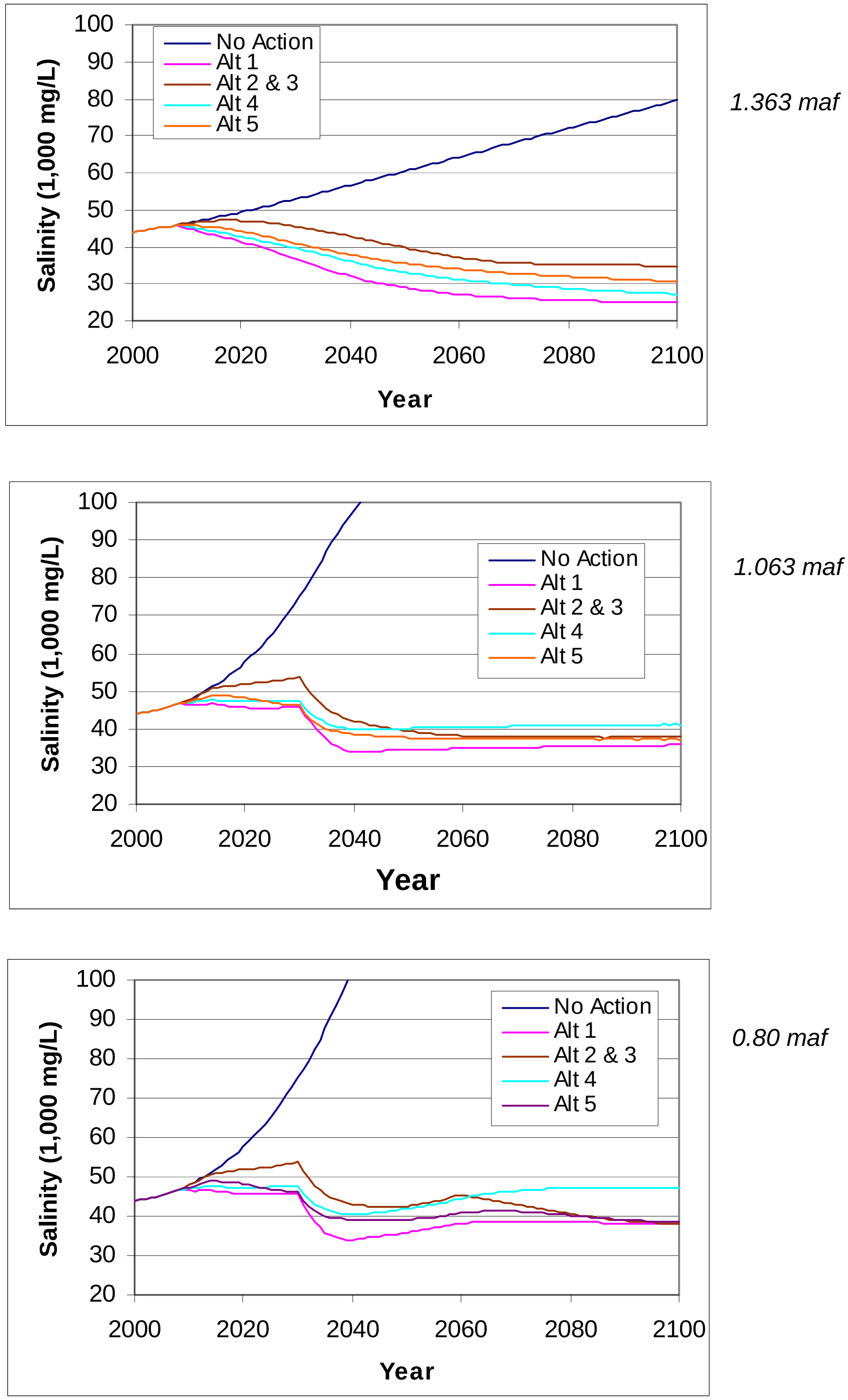
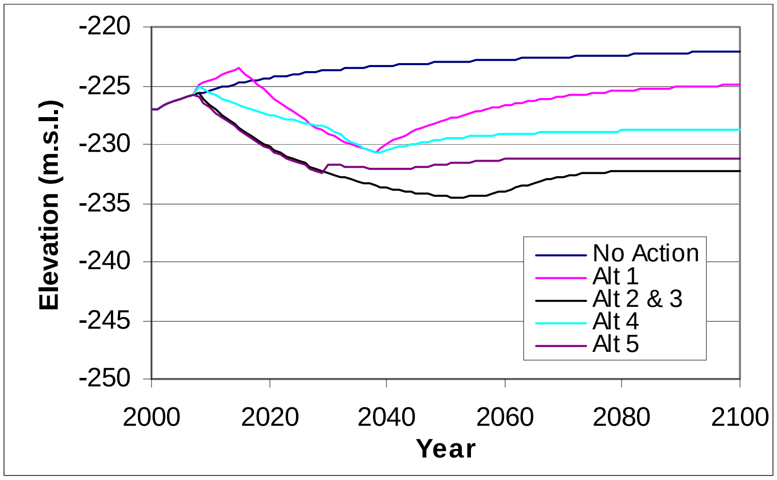
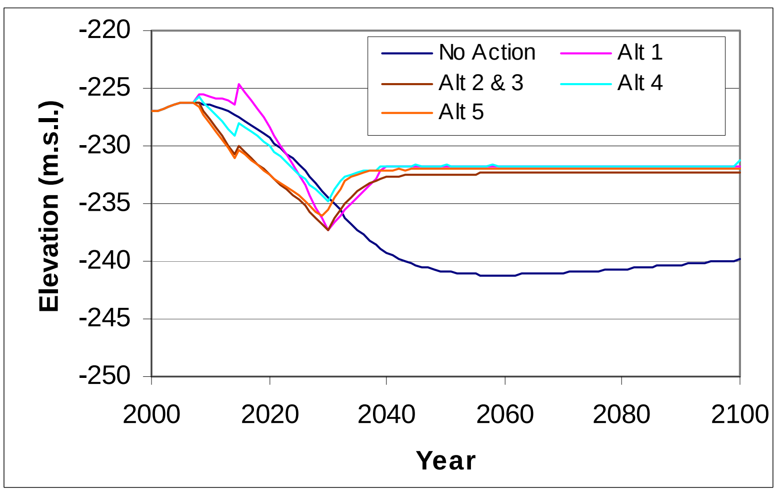


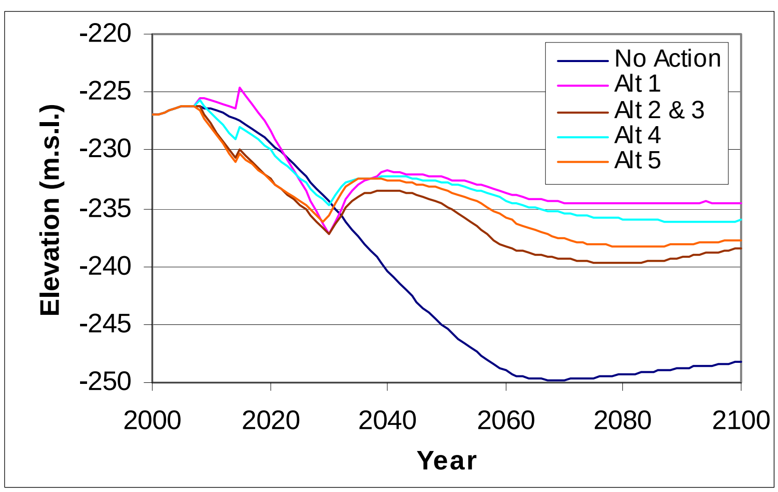
Figure 12.—Comparison of salinity among the alternatives at 1.363, 1.06, and 0.80 million acre-feet per year of inflow.



1.363 maf

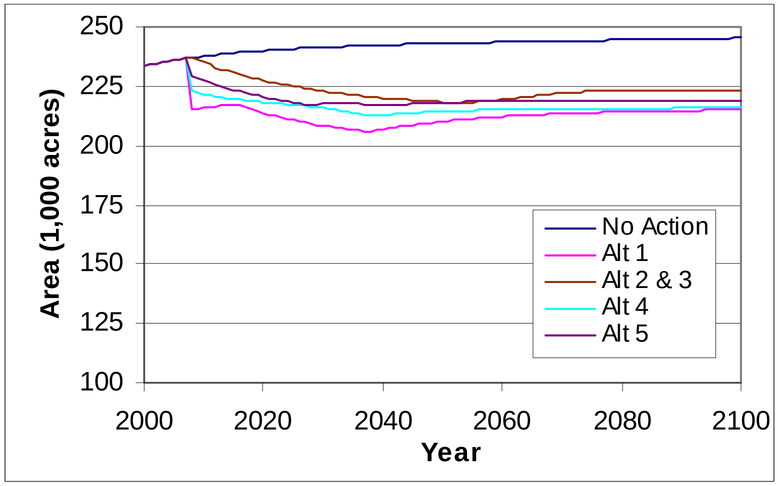


1.063 maf

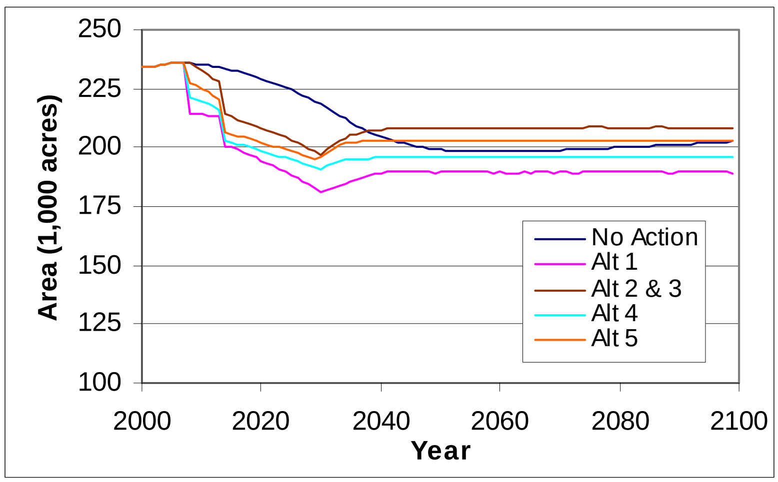


0.80 maf

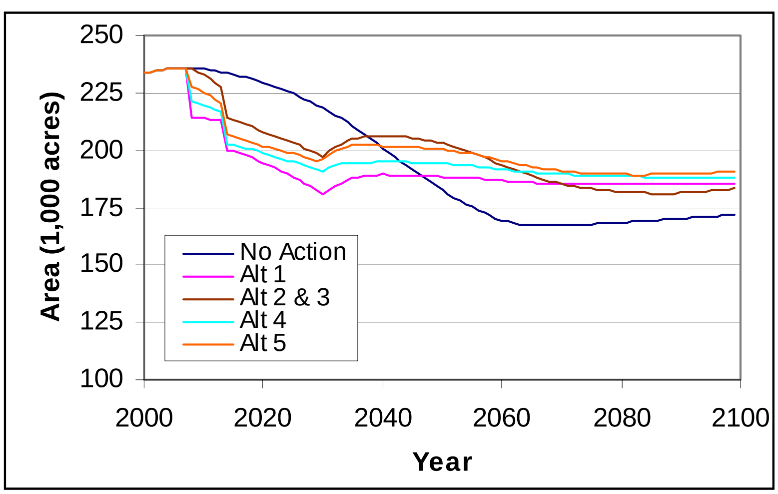
Figure 13.—Comparison of elevation among the alternatives at 1.363, 1.06, and 0.80 million acre-feet per year of inflow.



1.363 maf



1.06 maf



0.80 maf

Figure 14.—Comparison of area among the alternatives at 1.363, 1.06, and 0.80 million acre-feet per year of inflow.

III. ALTERNATIVES WITHOUT IMPORTS

Conditions in the Salton Sea will be significantly sensitive to whether or not CASI water will be available as an import. At an average annual inflow level of 1.063 million acre-feet per year, elevations in the Sea would be up to 13 feet lower and salinity would be more than 10,000 mg/L higher for extended periods of time if CASI water is not available.

The model indicates that the Sea would not be as affected if Colorado River flood flows are not available. Elevations would be affected by 2 to 3 feet without the flood flows at 1.063-million-acre-foot inflows. Salinity would be, at most, 2,000 mg/L higher without flood flows. If flood flows were available only through the year 2030 (without CASI imports), elevations could temporarily be raised 2 to 3 feet, and salinity could be reduced in the Sea by 4,000 to 5,000 mg/L.

At 1.063-million-acre-foot-per-year inflows, the combination of not having access to both flood flows and CASI import water would have the largest effects on the Sea whereby peak salinity values would be nearly 20,000 mg/L higher and elevations would be greater than 15 feet lower.

Additional information related to the sensitivity of model results to project features, as well as model input parameter and assumptions, is presented in attachment B.

IV. ALTERNATIVES WITHOUT DISPLACEMENT DIKE

An analysis of Alternative 2 at 1.063-million-acre-foot-per-year inflow with and without the proposed displacement dike shows that the lowest elevations in the Sea would be about 4 feet higher with the dike than without it. The peak salinity would be about 5,000 mg/L lower with the dike. Salinity would be lower because the surface area of the sea with the displacement dike in place would be about 15,000 acres less. The reduction in surface area provides a smaller surface for evaporation to occur, thus reducing the concentration effect that evaporation has on salinity within the Sea.

The displacement dike would reduce the surface area of the Sea to lesser degrees as the Sea elevation drops. At elevation -257, the surface area of the Salton Sea would be the same with and without the proposed dike.

Additional information regarding this analysis is found in attachment B.